would not move, and the observation was effected by noticing the circle on the diagram which came under the intersection of the cross wires. It is not very clear how the motion in the line of sight was measured, or how the effects of foreshortening were removed. There was no illumination, and the observations were confined to daylight. The general effect of the wind is to make the top of the Tower describe an ellipse, and several diagrams are reproduced showing the effect of the greatest storms. The maximum displacement occurred during the storm of December 20, 1893, when the major axis of the ellipse was 0·10 m., and the minor axis 0·06 m. The time occupied in the description of the ellipse would have been interesting, but is not given. The measured velocity of the wind at the moment of observation is recorded as 31·8 m. per second, or 71 miles per hour. During this storm a velocity of 44 m. per second, or 98 miles per hour, was recorded, but at that moment the major axis of the ellipse was only 0·06 m. This seems to have occasioned M. Eiffel some surprise, but fortunately these excessive gusts are generally operative over a very small area, and the total wind force on the Tower is not to be measured by that experienced at a point very near the anemometer. The same apparatus has served for the measurement of the effects of temperature. The curves traced are generally of a complex character, depending on the position of the sun, and consist mainly of small excursions into the north-west and west quadrants. An example is given of the motion on a very hot day in August, when the centre of the diagram practically traced an elongated ellipse, 24 cm. in length, parallel to the east and west direction.

The researches summarised in the volume appear to be rather unequal in value, and a very small connection with the Tower affords a sufficient warranty for their introduction. Thus we get some account of the recent balloon ascent of M. Santos Dumont, because it was a part of the scheme for testing the capacity of giving definite direction to such an apparatus that the Eiffel Tower should be included in the closed curve to be described by the aëronaut. Perhaps, however, one underestimates the part played by the Tower in this instance, for M. Emmanuel Aimé, slightly changing the well-known aphorism of Voltaire, assures us if the Tower did not exist it would be necessary to invent it for the necessities of aërostation. It seems, however, that M. Dumont prefers to pursue his experiments where he gets no assistance from the lofty structure. This tendency to stray from the subject is still more noticeable in the appendix, where we get a chapter "renfermant une notice sur les travaux exécutées par mes établissements industriels de 1867 à 1890." We have no desire to quarrel with M. Eiffel on this ground. He has carried out many great and difficult works in various parts of the world, and is to be congratulated on the success that has generally attended them. In forming our estimate of what he has accomplished for engineering science he should not be judged simply by the most popular or conspicuous example of his talent, but by the work of his whole career, which he may contemplate with complete satisfaction.

VOIGT'S ELEMENTARY MECHANICS.

Elementare Mechanik als Einleitung in das Studium der theoretischen Physik. Von W. Voigt. Zweite umgearbeitete Auflage. Pp. x + 578. (Leipzig: Veit, 1901.) Price Mk. 14.

THE object of this book is to provide the student of physics with a working knowledge of theoretical mechanics. With this view the reader is introduced successively to dynamics of a particle, dynamics of rigid bodies, attractions, hydrodynamics, elasticity; in each department statics holds a subordinate position, equilibrium being treated as a particular case. The design of presenting, within the compass of a volume of moderate size, an account of the things that are fundamental in the mechanics of bodies, whether solid or fluid, rigid or deformable, is entirely laudable. It brings into prominence the essential unity of subjects which are frequently treated as independent of one another; it imposes a selection of the topics to be discussed, and thus results in the elimination of much that is artificial and conventional though sanctioned by tradition.

A critical discussion of the principles of mechanics would perhaps have been out of place in a work of this character; at any rate it is not attempted by the author. His standpoint, so far as it is indicated, would appear to be nearer to that of Thomson and Tait's "Natural Philosophy" than to that of Kirchhoff's "Vorlesungen über mathematische Physik, Mechanik." As regards methods, it is noteworthy that the author makes comparatively little use of the conception of energy, and that he does not introduce Lagrange's equations. Accordingly, the stability of floating bodies is discussed geometrically after the manner of Dupin, and the small oscillations of a system with a finite number of degrees of freedom are not discussed at all. On the other hand, space is found for an account of "vector fields" and "tensor fields." The distribution of velocity in a fluid affords an example of a vector field, the distribution of strain in a body affords an example of a tensor field; with a vector field there is associated at each point a directed linear segment, with a tensor field there is associated at each point a certain surface of the second degree. Most recent continental writings on physical mathematics treat of vector fields. The chapter devoted to the dynamics of rigid bodies is made unusually interesting by the use of the theories of several pieces of apparatus—the balance, bifilar suspension, Atwood's machine, Foucault's pendulum—as illustrations of the mode of formation and solution of equations of equilibrium or motion the theory of the application of the pendulum to the determination of the acceleration due to gravity is also given. The treatment of rolling friction, of which two accounts, apparently conflicting with each other, are given in two separate articles, leaves something to be desired. An excellent feature of the book is the emphasis laid on the "dimensions" of physical quantities; no quantity is introduced without an explicit statement of its dimensions in terms of the units of mass, length and time.

The plan and purpose of the book require that the reader should not be assumed to possess a knowledge

of the theory of partial differential equations. This restriction renders necessary some originality of method in problems relating to fluid motion and to the equilibrium and motion of elastic solids. The book should prove very useful to teachers, by showing how much of these theories can be treated adequately by the aid of simple analysis. Perhaps the most remarkable piece of work, among those designed to make the theories of mathematical physics accessible to readers whose mathematical equipment is not very large, is the discussion of the equation of transverse vibrations of a stretched string; the writer founds the theory of this equation on a geometrical method, which was initiated by Riemann in his memoir on the propagation of plane sound waves of finite amplitude. The portion of the book dealing with deformable bodies contains, among other things, a very interesting account of *stress*; the notion of stress is introduced by means of a preliminary statement in regard to the observed character of the interactions between the smallest parts of bodies. Observation seems to be credited here with proving things which must, from the nature of the case, be remote inferences from observation. The subsequent deductive investigation is very well done. Viscosity in fluids receives a good deal of attention, and the divergences between the motions and resistances of perfect and of viscous fluids are illustrated by comparing the two solutions of the problem of the steady motion of a sphere through a fluid, regarded first as perfect and then as viscous, and by the contrast between the diffusion of vorticity in a viscous fluid and the permanence of vortex motion in a perfect fluid. Although it might be wished that the treatment of the fundamental theorem of rational hydrodynamics had been less summary, yet it will be felt that the student of theoretical physics owes a debt of gratitude to Dr. Voigt for his clear outline of the theories of fluid motion.

A. E. H. L.

ESSAYS ON BIRD-LIFE.

Birds and Man. By W. H. Hudson. Pp. 317. (London: Longmans, Green and Co., 1901.) Price 6*s.* net.

THE author of "The Naturalist in La Plata" is such a close and accurate observer of nature, and has such a rich store of anecdote upon which to draw, while his style is so fresh and invigorating, that a hearty welcome from the public is well-nigh sure to await all the efforts of his pen. In this little volume he has given us a delightful series of essays dealing with bird-life in England, in the course of which he dwells specially on the relations between bird and man as they exist in nature. Many of these essays have previously appeared in various serials, but a very considerable portion of the book, including the introductory chapter, is new.

Mr. Hudson has such an enthusiastic love for bird-life that, as he tells us in this introductory chapter, the sight of stuffed birds in a museum is positively painful to him. If this be so, an obvious and easy course lies before him, and it is unnecessary on his part to say that collections of this nature "help no one, and their effect is confusing and in many ways injurious to the mind, especially to the young." No one, of course, wishes to argue that stuffed birds are as good as living ones, but since the great majority of us have neither opportunity, time, patience nor money to devote to the observation of birds in their native haunts, we may surely be permitted, if we please, to study and admire their counterfeit presentments in a museum.

Perhaps the most interesting chapter in the book is the second, which bears the same title as the book itself. Here the author tries to imagine what birds think of man. At times, he thinks, they must be considerably puzzled, as when a blackbird is petted while on its nest by the owner of a garden, only to be shot at or stoned when it leaves the protected precincts.

"Birds" (says the author) "are able sometimes to discriminate between protectors and persecutors, but seldom very well, I should imagine; they do not view the face only, but the whole form, and our frequent change of dress must make it difficult for them to distinguish those they know and trust from strangers. Even a dog is occasionally at fault when his master, last seen in black and grey suit, reappears in straw hat and flannels."

Later on it is shown how birds clearly discriminate between dangerous and harmless mammals, the author giving us many interesting anecdotes derived from his Argentine experiences of the relations between birds and mammals in the wild state.

Several of the chapters—notably the one on the Dartford warbler—are devoted entirely to British birds, but in others the author takes a wider field. Among these latter the article on geese, with its description of the vast throngs of the Magellanic and upland species to be seen at certain seasons in Argentina, is of especial interest. It closes with a pathetic anecdote of a pair of these birds, which, on account of the female having a broken wing, started to *walk* the long journey from the pampas of La Plata to distant Patagonia.

In the two concluding chapters the author gives some supplementary notes on the birds of London, and describes his impressions on first visiting Selborne in 1896. In taking leave of this charming book we have two regrets—one that it is not longer, and the other that we have not space for a fuller notice.

R. L.

OUR BOOK SHELF.

The Earth's Beginning. By Sir Robert S. Ball, LL.D., F.R.S. Pp. viii + 384. (London: Cassell and Co., Ltd., 1901.) Price 7*s.* 6*d.*

THIS is a popular account of the nebular hypothesis, based upon a course of lectures adapted to a juvenile audience, and it is, therefore, almost superfluous to remark that the subject is presented in simple language and that no great mental effort on the part of the reader is called for. The theme is one which furnishes splendid opportunities for the display of the powers of graphic description and illustration for which the author is so well known, and the book will doubtless succeed in extending the interest in this fascinating chapter of science.

From the demonstration of the existence of true nebulæ, the reader is gradually led to the evidence that the sun and earth once existed in nebulous form, and thence to see how the present conditions of the solar system accord with the hypothesis. The difficulty presented by the anomalous revolutions of the satellites of Uranus and Neptune is got over ingeniously by supposing that in these cases the concordant stage of the evolutionary pro-